A COMPARISON STUDY ON VEHICLE TRAFFIC ACCIDENT AND INJURIES OF VULNERABLE ROAD USERS IN CHINA AND GERMANY

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ABSTRACT

The vehicle traffic accidents have been widely studied in different countries, but the difference of nature of traffic accidents in different countries was not adequately investigated for set suitable protective strategy in different area. This study aimed to identify the occurrence, type and mechanisms of the traumatic injuries of the vulnerable road users (VRUs) in vehicle collisions in China and Germany.

The accident data (in the years 2000 to 2005) were collected from traffic police and hospital in Changsha, China as well as from GIDAS database documented in Medical University Hannover, respectively. An in-depth study was carried out based on the collected data by using approaches of statistics analysis and virtual reconstructions. The results from analysis of Chinese data were compared with results from analysis of German data.

The injury severities were determined using AIS code and ISS values. The results were presented in terms of cause of injuries, injury distributions, injury patterns, injury severity. The VRUs accidents were identified as vital issue in urban traffic safety and therefore a high priority should be given to this road user group in research of safe urban transportation.

It was discussed with regard to accident data collection, accident sampling and injury distributions, the factors influenced the injury outcomes etc.

The data sources reflects the real situations of vulnerable road users in traffic accidents in Changsha and Hannover and may not in the whole countries of China and Germany.

This study will contribute to the determination of different nature of vehicle traffic accidens between motorized and motorizing areas, which will form a firm background for making safety counter-measures.

INTRODUCTION

In 2005, total of 98,738 road users were killed and 469,911 are injured in China, resulting in substantial economic losses due to fatalities and long-term consequences [1]. The vulnerable road users (VRUs) form a large proportion of the total fatalities. The safety issue of the VRUs is therefore to be a priority in the research of vehicle traffic safety in China. Knowledge from in-depth accident investigations will be valuable for improving VRU safety. It demonstrates an urgent demand for preventive measures.

In Germany 440,000 road users were injured in 2004, the half of these were aged between 25 to 65 years old, 5800 fatalities could be registered in that year, 14% were pedestrians[2].

Pedestrians are one of the most vulnerable road users in city traffic. They represent a high risk population since they are unprotected in vehicle impacts. About 25,000 pedestrians are killed in the traffic accidents each year in China [3]. In the European Union (EU) 7,000 pedestrians are killed each year, 5,000 in the USA, about 3,000 in Japan. Within the EU countries, the relative frequency of the pedestrian fatalities varies remarkably from 14% in Sweden to 32% in UK. Pedestrian protection is therefore a priority item in traffic safety strategies of nearly all countries worldwide [4].

The objective of this study is to identify the occurrence and type of the traumatic injuries of the relatively unprotected vulnerable road users especially the situation of the pedestrians in vehicle collisions, and to investigate the correlation of traffic injuries with human factor and engineering, environment factors, by using valid and reliable materials collected from local hospital and traffic administration authorities. The knowledge from the study is a prerequisite for developing guidelines to improve pedestrian safety and with this perhaps the safety for all other kind of vulnerable road users.

METHOD AND MATERIALS

Vehicle accident data were collected from Changsha in China. The Changsha is a capital city of Hunan

Province, which is located in south middle of China, with a population 2,060,000 in the city center, 6,133,000 including residents in suburb and registered vehicles 255,599 in 2000.

Figure 1. The urban area of Changsha, the capital of Hunan Province located in south middle of China.

In the present study, a general statistic analysis was carried out in terms of occurrence and type of the accidents of the unprotected vulnerable rod users, especially the situation of the pedestrians in vehicle collisions. A preliminary analysis was also carried out to identify the type of pedestrian accidents in terms of involved vehicles.

Analysis of pedestrian injuries was carried out using collected data from hospital in terms of cause of injuries, injury distributions, injury patterns, and injury severity.

Pedestrian accident cases collected from the accident database GIDAS (German In-Depth Accident Study) were used for an in-depth analysis of pedestrian injuries.

A comparison was carried out in terms of analysis results based on accident data from Changsha and Hannover. The factors influenced the injury outcomes were proposed and discussed in terms of vehicle transport environment and road users. The results were discussed with regard to accident data collection, accident sampling and injury distributions etc.

Finally, accident reconstructions are conducted using mathematical models to study the impact dynamics and injury biomechanics in pedestrian traffic accidents.

Accident data from Changsha

The accident data from Changsha consist of two parts: one part of the data was collected from Traffic Police Section, another part of the data was collected from Wujing Hospital. The hospital admits the patients with traffic trauma in the urban area of Changsha.

Police data

There are total 19,323 accident cases in traffic police database registered from 2001-01-01 to 2005-12-31. Total of 42998 victims involved in the accidents. Among 19,323 accidents, 3603 cases were pedestrian accidents, accounted for 18.7% of all reported accidents, 1473 cyclist cases, 7.6%, 1447 motorcyclist cases, 7.5%.

Table 1: Distribution of vulnerable road user accidents

	Accidents	%
Pedestrian	3603	18.7%
Cyclist	1473	7.6%
Motorcyclist	1447	7.5%
Others	12800	66.2%
Total	19323	100%

Of 42998 victims, 4% were killed, 5% were severely injured, 36% were slightly injured, and 55% had no injuries.

Table 2: Comparison of proportions of injury severity

	Victims	%
Fatalities	1934	4%
Seriously injured	2003	5%
Slightly injured	15325	36%
No injuries	23736	55%
Total	42998	100%

This police database has total 3,603 pedestrian victims, of which 16% victims were killed, 11% were severely injured, 72% were slightly injured, and 1% pedestrians had no injuries.

This police database has total 1,496 cyclist victims. Among those victims, 9% cyclists were killed, 11% were severely injured, 77% were slightly injured, and 1% had no injuries.

Hospital data

An in-depth study on the hospital clinical records for 622 traffic injury patients was carried out in cooperation between researchers and medical doctors. In total of 403 cases were collected based on the study of the clinical report from 2000 to 2005. The hospital data are summarized according to accident date, patient age, gender, and available information about injury pattern, injury severities, as well as type of accident vehicles. Pedestrian accident data were also collected from traffic administration authorities with information about accident sites and vehicles based on accident report. 72 cases of the pedestrian patients were selected with detailed injury descriptions for determination of the injury severities and analysis of pedestrian injuries using AIS [5] code and ISS value. The situation of

treatment period and heal was studied based on hospital documentations to identify the consequence of accident.

GIDAS accident data from Hannover Medical University

In the district of Hannover a representative sampling of accidents was carried out by the order of German Government (Federal Highway Research Institute BAST) in cooperation with the car manufactures FAT since the year 1999 (Otte et al, 2003). In the area of Hannover nearly 1000 accidents with injured person are collected there annually in a continued and representative way. These accident cases were documented in the accident database GIDAS by Accident Research Unit at Medical University of Hanover. The collected cases in the GIDAS database contain very detailed information about pedestrian victims on age, gender, height/weight, injuries, speed determination and details of the accident cars as well as the accident scene issues.

Altogether 407 vehicle-to-pedestrian accident cases from the GIDAS database were collected based on the following standards: (1) the pedestrian should sustain at least an AIS 1 injury; and (2) the accident occurred during the period from 2000 to 2005.

Accident Reconstructions

In passenger car-to-adult pedestrian accidents, the head injuries attract particular attention due to the severe or fatal consequences. Many studies have been carried out in this area but the injury mechanisms and the tolerances of brain remain controversial. This study presents an approach (Figure 2) to investigate the skull-brain injury mechanisms by using a MBS pedestrian model and a head FE model. Furthermore, the acquired knowledge will be used for assessment of the risks of head brain injuries, and improvement of the car safety design for protection of pedestrian head injuries.

A FE model of human body head (HBM-head) was developed[6, 7] based on anatomical features of a 50th percentile male adult head with mass 4.4 kg (Figure 2). The HBM head model consists of scalp, skull with dura, falx cerebri, tentorium, falx cerebelli, pia, cerebrum, cerebellum, brain stem and ventricles. The properties of brain soft tissues exhibit incompressible behavior, which were defined using visco-elastic material model. The HBM-head FE model was validated in terms of the intracranial and ventricular pressure with two load pulses from cadaver impact tests at speeds of 9.94 and 6.80 m/s.

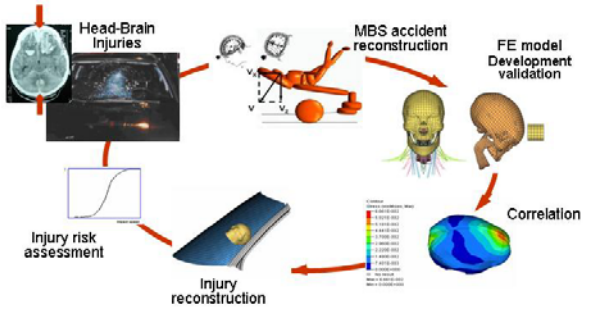
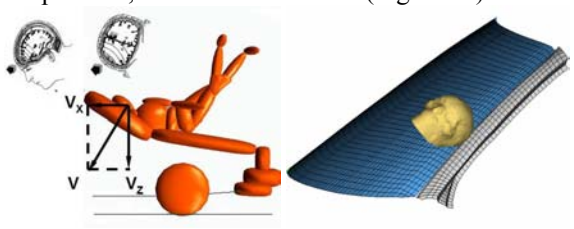


Figure 2: An approach to study pedestrian skull-brain injuries using MBS and FE models.

A passenger car-to-pedestrian crash was carried out using multi-body system (MBS) models to acquire the head impact conditions for the head impact velocity, head position, and head orientation (Figure 3a).



(a) (b)

Figure 3: (a) A multi-body dynamic model of a car to pedestrian impact, (b) HBM-head FE model impact to windscreen and A-pillar.

The HBM-head FE model was used for reconstruction of skull fracture and brain injuries via a virtual test of head impact against windscreen and A-pillar (Figure 3b). A stress analysis was conducted to determine the correlation of the stress and pressure distributions of the brain model with the injuries observed in the head-windscreen collisions.

RESULTS AND ANALYSIS

Involvement of vehicles

Considering vehicle types involved in accidents in Changsha, the pedestrians were struck most frequently by passenger car and motorcycle. Figure 4a shows approximately 52 % of the accidents are passenger cars, and 22 % motorcycle-pedestrian collisions, 16 % truck, and 3.5 % bicycle. Compared to the China´s situation for Germany there can be registered mainly car involvement in pedestrian collisions (80.6%) (Figure 4b).

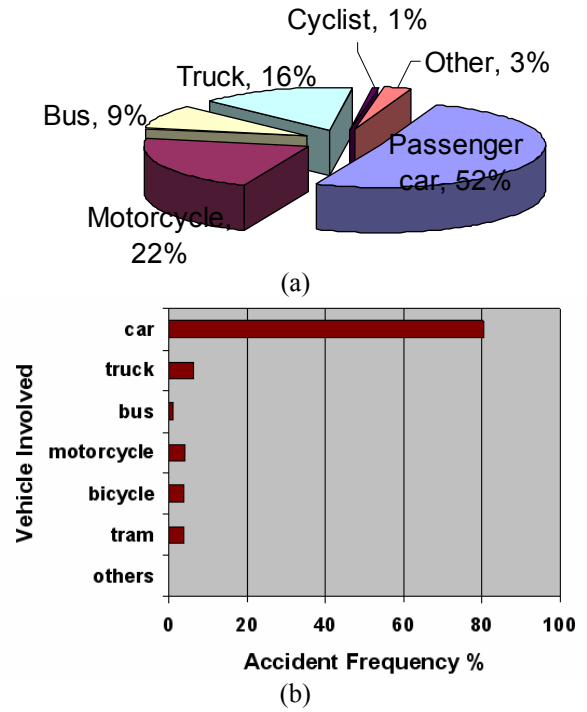


Figure 4. Frequency distribution of vehicle type in pedestrian accident: (a) 3603 cases from Changsha Traffic Police Station, (b) 407 cases from GIDAS Hannover.

Frequency of Pedestrian Accidents

An analysis of frequency of pedestrian accidents was conducted with the collected data in terms of age groups, gender and injured body parts.

Age distribution in pedestrian accidents

Figure 5a illustrates the age distribution in pedestrian accidents for Changsha. 7.9% of injured pedestrians are children under 15 years old. The pedestrians under 20 years old accounted for 18.1%. 71.9% of pedestrians involved in an accident were adults from 21 to 60 years old and formed the big group. Elderly pedestrians 60 years old above accounted for 9.9% of all injured pedestrians.

Figure 5b illustrates the distribution in pedestrian accidents for Hannover in different age groups: 32,5% for child pedestrians under 15 years old, 42,3% for pedestrian under 20 years old, 36,4% for 21-60 age group, and 21,4% for older pedestrians >60 age group.

It can be seen that in Germany the highest risk exsiting for young and old pedestrians, compared to this in China the adult group of 20 to 50 years old is injured mainly.

Gender distribution in pedestrian accidents

Table 3A and 3B (Appendix) present the results for the age distribution of injured pedestrians in terms of gender. Of the Changsha pedestrians, 67 % of the pedestrians are male and 33 % are female. Of the Hannover pedestrians, 51.9 % are male and 48.1 % are female. We noted that the male pedestrians encounter in both countries for higher risks than that for females in vehicle accidents.

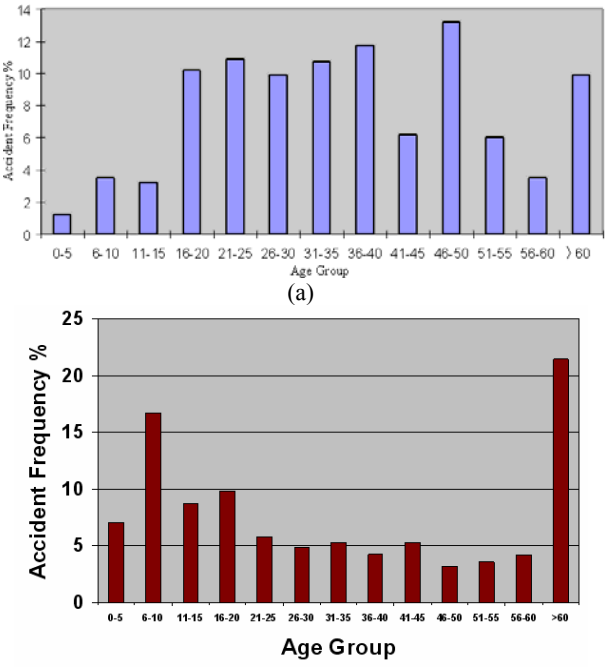


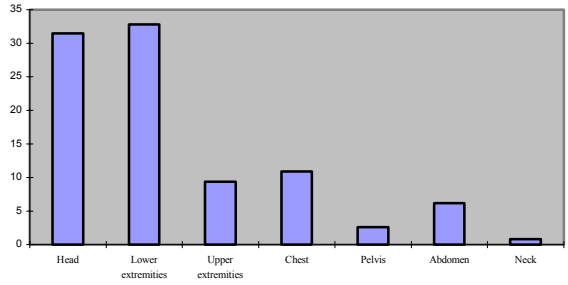
Figure 5 Frequency distribution of age group in pedestrian accident (a) 403 cases from Changsha Wujing hospital, and (b) 206 cases from GIDAS Hannover

Distribution of injury frequency by body parts

Figure 6a presents the results for the distribution of injured body parts from Changsha cases. The head and lower extremities were found to be the most frequently injured[4]. Of the total pedestrian patients, 31.5% suffered head injuries. The lower extremity injuries accounted for 32.8%, and upper extremities 9.4%. In pedestrian accidents chest and pelvis injuries also took a significant proportion of 13.5 % of all injuries. Abdominal injuries were found in 6.2%, and the neck injuries were relatively rare, in 0.8%.

Figure 6b presents the distribution of injured body parts for Hannover GIDAS data. 50.7% suffered head injuries. The lower extremity injuries accounted for 63.5%, and upper extremities 38.7%. In pedestrian accidents chest and pelvis injuries also took a significant proportion of 17.1 % for the thorax and 13.0% for the pelvis. Abdominal injuries were found in 6.3%, and the neck injuries were relatively rare, in 3.6%. The injury distribution is similar between China and Germany, the head and the legs are the major

exposed injured body parts, in Germany a higher injury risk of the arms can be seen in the diagrams.



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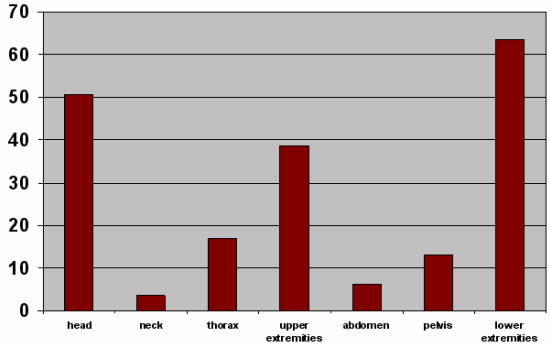

(b)

Figure 6. Distribution of injury by body regions pedestrian (a) Changsha, and (b) GIDAS Hannover

Severity and distribution of pedestrian injuries

For an in-depth study of pedestrian injuries Changsha 72 cases were selected from the Wujing Hospital with a sampling defined as follows: (1) the injuries were described with very detailed information which can be used to determine the injury severity with AIS code; (2) the pedestrian should sustain at least an AIS 1 injury; and (3) accident occurred during the period from 2000 to 2005.

AIS coding and analysis

The severity of injury sustained by individual body area is given in Table 4. The percentage is that the number of body segment injuries refer to the total number of registered injuries by injury severity. With the detailed information of 72 cases from Wujing hospital, the injuries are rated on the AIS scale[5]. The overall injury severity classified with AIS code is summarized in Table 4A. 59.7 % of the cases with AIS 1 and 2 minor/moderate injuries, and 25 % with serious injuries, the severe and critically injured pedestrians are 9.7% and 5.6 %, respectively. It was found that head and lower extremities were, again, the body parts most frequently injured. From the clinical documentation in Wujng hospital we noted that the head injury patterns are skull fractures and brain injuries, including cerebral concussion, lacerations, contusion, and intracranical hematoma. The common thorax injury patterns are rib fractures with hemoth and pneumoth. The leg injuries are more frequent than upper thigh fractures including the toe, tibia, fibula fracture. The pelvis injuries are parenchyma contusion.

With the detailed information of GIDAS Hannover, the overall injury severity classified with AIS code is summarized in Table 4B. 90.8% of the cases with MAIS 1 and 2 minor/moderate injuries, and 6.2% with MAIS 3 serious injuries. The severe and critically injured pedestrians (MAIS 5/6) are 2.1%.

Table 4A: Injury severity of pedestrians in selected 72 cases (Changsha)

Injury Severity	MAIS	Number	%
Minor	1	3	4.2
Moderate	2	40	55.5
Serious	3	18	25.0
Severe	4	7	9.7
Critical	5	4	5.6
Fatal	6	0	0
Total	–	72	100

Table 4B: Injury severity of pedestrians in collected 206 cases (GIDAS Hannorver)

Injury Severity	MAIS	Number	%
Minor	1	231	68.3
Moderate	2	116	22.5
Serious	3	36	6.2
Severe	4	7	1.0
Critical	5	13	1.6
Fatal	6	4	0.5
Total	-	407	100

The compared injury distribution between Changsha /Hannover are shown the different sampling criteria, the data of Hannover consider the whole injury distribution in a statistical manner (minor to fatal). Changsha cases are representing the situation of a hospital, therefore directly died persons at the scene (MAIS 6) are not included.

ISS value and analysis

The ISS value was calculated for the selected 72 cases from Changsha and 206 cases from GIDAS. Table 5 (Appendix) presented the calculated ISS values.

The injury severity grade ISS is a good predictor for the whole severity of the injured body related to the complexity of treatment and the outcome of survival. It can be seen that the german injured pedestrians has a better injury outcome, 91.7% suffered ISS<10. A polytraumatized victim with risky treatment starts at

ISS values above 15. In Germany those cases can be seen in 3.3% cxompared to China in 16.6%.

Analysis of injury severity by body regions in age groups

Table 6 (Appendix) presented distribution of injury severity by pedestrian body regions, and Table 7 (Appendix) presentd Distribution of injury severity by age group.

In all age groups the injury risk is very high for the China situation compared to the German situation. Nearly three-quarter of the Hannover pedestrians suffered injury severity grades MAIS 1 only, expect the older age group of >60 years old (54.8%). 26.0% were MAIS 3+ injured. Compared to this 62.5% of the greater 60 years old pedestrians were MAIS 3+ injured in Changsha. A very low number of minor injured pedestrians could be registered there in all age groups.

Correlation of skull-brain injuries with physical parameters

From head-windscreen impact, the received contact force of the HBM-head model is 4.4kN and the intracranial pressure maximum 250kPa. From head-A-pillar impact, the received contact force of the HBM-head model is average 16kN and the intracranial pressure maximum 815kPa.

The skull fracture appeared in an A-pillar impact, and there is lower risk of skull fracture in windscreen impact. The intracranial pressure maximum 250kPa from windscreen impact could correlate with minor coup/countercoup injuries. The intracranial pressure maximum 815kPa from A-pillar impact could predict severe coup/countercoup injuries.

The simulation of head-brain impacts indicated that coup/countercoup pressure, Von Mises and shear stress were important physical parameters to evaluate the brain injury risk.

The correlation of skull fracture with the predicted physical parameters can be determined. Thereby, we can finally obtain reasonable advices to improve safety design of car frontal structure for minimizing the risk of pedestrian head injuries.

DISCUSSION

Causation of Injuries

The vehicle traffic accidents steeply increased in the past decade worldwide therefore in China as well as in Germany. But the injury situation related to traffic accidents seems to have different pictures for Germany and China. The annually fatalities in the reported accidents of China increased from 49,271 in 1990 to 107,000 in 2004. The road traffic authority made large efforts to control incidence of the accidents, but the tendency of the accident growth is still a critical issue in China. Particularly, the fatalities of vulnerable road users formed a main proportion of all reported fatalities in traffic accidents. For instance about 12,500 pedestrians were killed in 1990, and 26,000 in 2001, which accounted for about 26% of all traffic fatalities annually. Compared to this, for Germany the number of causalities could be reduced over the last 30 years continuously to a total number of currently 5361 in 2005. The percentage of fatal pedestrians built 13% on that total number.

The present study is based upon an analysis of 403 accidents in urban area of Changsha in China and the area of Hannover in Germany. The evaluation method was described and the available accident data were analyzed. The used samples are small, but as a preliminary study the presented methodology for an in comparison of different in-depth accident studies could be used for comparison of the injury risk and injury outcome for different countries. Such methodology can be used for further studies with new collection of accident data in the area and special research issues.

It was found that the present results are quite comparable with results from studies by other researchers. For instance, the pedestrian accident is a common problem in both motorized countries and motorizing countries, which occur frequently in city build up area, but the injury risk for pedestrians in Germany can be seen as much less danger as in China. On the other hand the combined results of the in-depth analysis of the two different areas of China and Germany are shown major resources for further countermeasures on car safety developments, i.e. young and old pedestrians needs to focus in Germany, adult pedestrians 20 to 50 years old needs to protect more in China. The finding of the frequency in age distribution is quite different from that in other motorized countries. Child pedestrian accidents accounted for 25.3% in the USA, 33.1% in Europe, and 34.2 in Japan. A further study is needed to identify the factors which affect the different results.

Pedestrian accident analyses have been conducted worldwide in the past four decades[8-11]. Pedestrian impact conditions and injury outcomes were identified from these studies. The findings of the distribution of pedestrian injuries to different body segments are compared between the results from this study and results from published studies by other researchers worldwide as presented in Table 6, showing the distribution of injured body regions (100%). As a common tendency, the head and the lower extremities

have been found to be the most frequently injured body regions.

The analysis of pedestrian accidents in Changsha indicated that motorcycles and passenger cars are most frequently involved in vehicle pedestrian accidents compared to Germany where the major collision partner of a pedestrian is a car (80.6%). 43.9 % of the accidents in Changsha are motorcycle-pedestrian collisions, and 30.3 %, passenger cars. In the EU countries, the number of pedestrian strucked by passenger cars is around 60% to 85% of the reported vehicle pedestrian accidents[6], and 56% of the reported pedestrian accidents are caused by passenger cars in the USA. Due to the difference of involved vehicles from country to country, the priority of safety countermeasures should be given considering the frequency of involved vehicles [13-16].

Counter-measures

Even that for Germany a good reduction of the number of fatalities and severe injured pedestrians can be registered over the last decade further measurements for safety can be seen as important, the head injury risk and the risk of lower extremities should be focussed in the future.

There is great potential of reduction of the accidents and fatalities in China by enhancing safety consciousness of all road users, improving the traffic administration, and strictly implementing traffic laws.

It is necessary to point out that a large amount of the accidents resulted from people's mistake. The accidents and accident casualties mainly attributed to the causation factors. This study considered not the aspects of causation, but in-depth-analysis could be also a good tool for such research in different countries.

Limitations

It is also noticed that the limitations existed in this study. The data sources partly reflects the real situations of pedestrians in traffic accidents in Changsha and Hannover and not in the whole countries of China and Germany. On the other hand, the used samples are influenced by their specific sampling criteria being different for Changsha and Hannover. For Changsha in some cases the medical records were not complete due to that the injured pedestrians left the hospital without the continual cure and the reports could not point out whether they have healed and in the sample not those fatalities were included which died directly on the scene. Another problem existed in Changsha on the medical records provided comprehensive data on the injuries , they seldom provided exact details of the locations and extent of the injuries, and it bring up a difficulty to classify the injuries according to the AIS code. Compared to this the data of GIDAS Hannover are comprehensive and give information on every issue of accident and injury details [6].

5 CONCLUSIONS

Pedestrian accidents represent a group of vulnerable road users with high risk of unprotection, and in relation with the importance of pedestrians within the traffic of a country therefore a high priority should be given to this road user group in research of safe urban transportation.

About over two thirds of injured pedestrians are male pedestrians. The exposure of injury risks to elderly people is much higher than that to younger pedestrians. This seems to be relevant for the German situation where the major injured pedestrians could be seen. In Changsha the main focus has to be given to the adults in the age of 20 to 50 years of age. In urban area of Changsha motorcycles and passenger cars are most frequently involved in vehicle pedestrian accidents.

The head and lower extremity injuries are the predominant types of pedestrian injuries. Chest and pelvis were frequent injured, then followed by abdomen injuries, whereas injuries to upper extremities and neck were relatively infrequent. It is necessary to give the priority of injury prevention to the head and lower extremities. Meanwhile in China many European Cars are driven, therefore it can be expected that in some years the same safety standard and injury risk will be approached. Further in-depth studies may identify this common approach.

6 ACKNOWLEDGMENT

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APPENDIX

Table 3A: Distribution of pedestrian age and gender in traffic accidents (Changsha)

Age / Gender	0-15yr		16-60yr		>60yr		Total	
	Number	%	Number	%	Number	%	Number	%
Female	13	40.6	101	30.5	19	47.5	133	33.0
Male	19	59.4	230	69.5	21	52.5	270	67.0
Total	32	100	331	100	40	100	403	100

Table 3B: Distribution of pedestrian age and gender in traffic accidents (GIDAS Hannover)

Age / Gender	0-15yr		16-60yr		>60yr		Total	
	Number	%	Number	%	Number	%	Number	%
Female	49	38.3	89	48.7	56	61.6	194	48.1
Male	79	61.7	97	51.3	37	38.4	213	51.9
Total	128	100	186	100	93	100	407	100

Table 5: Correlation of injury severity with ISS value

ISS	Changsha data		GIDAS data		Sevirity
	N	%	N	%	
< 10	53	73.6	350	91.7	Minor
10-15	7	9.7	28	5.0	Moderate
16-19	7	9.7	5	0.8	Serious
20-39	5	6.9	11	1.4	Severe
40-66	0	0	5	0.6	Critical
75	0	0	4	0.5	Fatal
Sum	72	100	403	100	-

Table 6A: Distribution of injury severity by pedestrian body regions (Changsha)

Injury severity / Body segment	Slight, AIS<3 (N= 43)		Serious, AIS=3 (N= 18)		Fatal, AIS>3 (N= 11)		Total (N= 72)	
	Injury	%	Injury	%	Injury	%	Injury	%
Head	23	67.6	2	5.9	9	26.5	34	100
Face	9	100	0	0	0	0	9	100
Lower extremities	24	66.7	12	33.3	0	0	36	100
Upper extremities	3	100	0	0	0	0	3	100
Chest	6	66.7	3	33.3	0	0	9	100
Pelvis	3	100	0	0	0	0	3	100
Abdomen	3	60	2	40	0	0	5	100
Neck	0	0	0	0	0	0	0	0

Table 6B: Distribution of injury severity by pedestrian body regions (GIDAS Hannover)

Injury severity / Body segment	Slight, AIS<3 (N= 347)		Serious, AIS=3 (N=36)		Fatal, AIS>3 (N=24)		Total (N= 407)	
	Number	%	Number	%	Number	%	Number	%
Head	192	94.0	7	1.9	15	3.1	214	100
Lower extremities	232	92.2	30	7.5	1	0.3	263	100
Upper extremities	144	97.5	6	2.5	0	0	150	100
Chest	62	85.8	6	5.2	13	9.0	81	100
Pelvis	54	97.7	1	0.4	2	1.9	57	100
Abdomen	24	91.7	1	1.0	3	7.3	28	100
Neck	15	87.4	0	0	3	12.6	18	100

Table 7A: Distribution of injury severity by age group (Changsha)

Age / MAIS	0-15yr		16-60 yr		>60 yr		Total	
	Number	%	Number	%	Number	%	Number	%
1	1	16.7	2	3.4	0	0	3	4.2
2	1	16.7	35	60.3	3	37.5	39	54.2
3	1	16.7	12	20.7	5	62.5	18	25
4	2	33.3	6	10.3	0	0	8	11.1
5	1	16.7	3	5.2	0	0	4	5.6
6	-	-	-	-	-	-	-	-
Total	6	100	58	100	8	100	72	100

Table 7B: Distribution of injury severity by age group (GIDAS Hannorver)

Age / MAIS	0-15yr		16-60		>60		总计	
	Number	%	Number	%	Number	%	Number	%
1	81	72.4	110	71.6	40	54.8	231	68.3
2	40	23.2	47	18.8	29	29.3	116	22.5
3	6	4.0	17	6.0	13	10.0	36	6.2
4	0	0	3	0.9	4	2.6	7	1.0
5	1	0.4	7	2.1	5	2.3	13	1.6
6	0	0	2	0.5	2	1.1	4	0.5
Total	128	100	186	100	93	100	407	100

Table 8: Comparison of percentage distribution of pedestrian injuries by body region

Body region	China (Changsha)(%)	GIDAS (%)	Europe (%)	Australia (%)	Japan (%)	USA (%)
Head	31.5	26,4	29.8	39.3	28.6	32.7
Face*	5.8	-	5.3	3.7	2.4	3.7
Neck	0.8	2,2	1.8	3.1	4.5	0.0
Chest	10.9	10,0	11.6	10.4	8.5	9.5
Abdomen	6.2	3,5	3.8	4.9	4.8	7.7
Pelvis	2.6	7,0	7.9	4.9	4.5	5.3
Upper extremities	9.4	18,5	8.1	8.0	9.0	7.9
Lower extremities	32.8	32,4	31.3	25.8	37.2	33.3
Unkown	0.0	-	0.5	0.0	2.1	0.0
Total	100	100	100	100	100	100

* not distinguished from head injuries.